VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

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VIRGINIA DEPARTMENT OF HEALTH (VDH) GUIDELINE FOR ACCEPTABLE LEVEL OF INDOOR FORMALDEHYDE IN TEMPORARY HOUSING UNITS

Background

Environmental exposure to formaldehyde has received considerable attention in recent years. In the aftermath of Hurricanes Katrina and Rita, the Federal Emergency Management Agency (FEMA) provided travel trailers and mobile homes to Gulf Coast victims who had lost their homes in the hurricanes. Concern has surfaced about air quality in the trailers and the occurrence of respiratory and other symptoms, resulting from exposure to formaldehyde.

Formaldehyde is a colorless gas with a pungent odor. It is produced endogenously in the body and is present in many foods. It is used in resins, glues, permanent press or crease-resistant fabrics, tissue preservatives, disinfectants, fumigants, pesticides and a variety of household products. In the past, formaldehyde was also used in the insulation of many homes. Formaldehyde resins are used in the manufacture of wood products, such as particle board, medium density fiber board, and plywood, all of which have been used in site-built homes, mobile homes, and travel trailers. When these building materials are used, the formaldehyde gas may be released into the air (called off-gassing) inside the structures and expose residents to levels that could cause health effects.

Health Effects

Acute (short-term) and chronic (long-term) exposure to formaldehyde in humans can result in eye, nose, and throat irritation, respiratory symptoms, and sensitization. Limited human studies have reported an association between formaldehyde exposure and nose cancer.

Inhalation exposure is considered a major route of exposure to formaldehyde from FEMA trailers. The principal effect of low concentration of formaldehyde observed in humans is irritation. Because it is very soluble in water, formaldehyde irritates mucous membranes of the nose, upper respiratory tract, and eyes. Complaints include headaches, fatigue, sore throat, inability to concentrate, nosebleed, and thirst. The most sensitive person experiences slight eye irritation at 10 parts per billion (ppb), and some can perceive the odor at concentrations as low as 50 ppb. At 100-3,000 ppb most people experience eye, nose and throat irritation. The number of symptoms, their severity, and the number of people affected increases with dose.

Substantial information exists to indicate that at levels exceeding 100 ppb of formaldehyde, many people develop irritant effects from exposure. The irritation that results is from stimulation of the trigeminal nerve endings, evoking a burning sensation of the nasal passages and burning and tearing of the eyes. The effect is readily reversible once exposure ceases. Formaldehyde not only stimulates nerves, it also causes tissue damage at the site of contact. At low levels of exposure, recovery occurs during periods of nonexposure. Even more advanced pathologic changes possess a degree of reversibility. At some point, however, the process becomes irreversible and a carcinoma (malignant tumor) may be produced. Irritation, therefore, should be viewed as an early warning stage in a process that can lead to progressively more severe health effects.

Repeated exposure to formaldehyde may cause some individuals to become sensitized, or hypersensitive. Sensitization may occur days, weeks, or months after the first exposure. Sensitized individuals will experience eye and upper respiratory irritation or asthmatic reaction at levels of exposure that are too low to cause symptoms in most people. Reaction may be quite severe with swelling, itching, wheezing, and chest tightness. Studies have shown that children chronically exposed to indoor formaldehyde levels greater than 16 ppb show an increased incidence of allergic sensitivities and respiratory symptoms (such as coughing) and increased likelihood of having asthma. Indoor formaldehyde levels greater than 50 ppb have been associated with increased risk of diagnosed asthma. Formaldehyde appears to have a large impact on children's health. For example, in one study, 16% of children in homes with formaldehyde concentrations less than 16 ppb had diagnosed asthma, while 44% had asthma in homes with formaldehyde concentrations greater than 40 ppb. The scientific literature to date shows an association between formaldehyde exposure and inflammation of lung tissues, sensitization to allergens, and potentially altered immune system development in children, all of which are involved in the development and progression of asthma.

Long-term exposure to formaldehyde can cause cancer in both animals and humans. Laboratory animals that were exposed to high levels for an extended time have shown a tendency to develop cancer of the lining of the nose, where formaldehyde first contacts. Although human studies have not clearly shown the same tendency, the International Agency for Research on Cancer (IARC) and the State of California have classified formaldehyde as a known human carcinogen and recommend keeping exposure as low as possible. The State of California has determined that exposure to formaldehyde at 2 ppb results in a 1 in 100,000 lifetime risk of cancer.

Basis of Guideline

The VDH has been tasked with developing a guideline for an acceptable level of formaldehyde in temporary housing units. VDH considered the following in developing the guideline: 1) levels of formaldehyde expected in other forms of housing and 2) existing health standards and guidelines on indoor air levels of formaldehyde.

Levels of Formaldehyde in Housing: Formaldehyde is frequently used in plywood, fiber board, resins, glues, and other building materials. Several studies have reported data on measured levels of formaldehyde in different types of housing. The most recent studies have reported typical levels of 17 ppb in single-family homes, and levels ranging from 16-25 ppb in mobile homes or trailers. The formaldehyde levels found in travel trailers, mobile homes, and park models are generally higher than typical background levels found in conventional homes. In 2008, the Centers for Disease Control and Prevention (CDC) measured formaldehyde levels in FEMA-supplied travel trailers, mobile homes, and park models. The average level of formaldehyde in these housing units was 77 ppb.

Factors which affect the concentrations of formaldehyde in indoor air include the types and quantity of source materials, ventilation, temperature, and humidity. The release of formaldehyde is expected to decrease from wood-based building materials as they age. The concentration of formaldehyde in mobile homes would be expected to be higher than that found in conventional homes due to their lower rate of air exchange. The levels of formaldehyde appear to decrease as the mobile home and the formaldehyde-based resins age, with a half-life of 4 to 5 years.

Existing Health Standards and Guidelines: At present, there is not a generally agreed upon U.S. federal government standard or guideline for formaldehyde levels in residential indoor air, especially for trailers and mobile homes. In contrast, Health Canada has developed a residential indoor air guideline for formaldehyde of 40 ppb for an 8-hour exposure period and 100 ppb for a 1-hour exposure period. The World Health Organization (WHO) has developed a residential indoor air quality guideline for

formaldehyde of 100 ppb in order to minimize the risk of repeated or continuous low concentration exposure to formaldehyde. Similarly, the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) recommend a maximum continuous indoor air concentration of 100 ppb.

The Agency for Toxic Substances and Disease Registry (ATSDR) has developed Minimal Risk Levels (MRLs) for formaldehyde. ATSDR's acute inhalation MRL is 40 ppb for exposure of 1 to 14 days; the intermediate inhalation MRL is 30 ppb for exposure of 15 to 364 days; and chronic inhalation MRL is 8 ppb for 365 days or more. MRL is an estimate of daily human exposure to a dose of formaldehyde which is likely to be without an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure. These MRLs are not meant to support regulatory action, but to acquaint health officials with exposure levels at which adverse health effects are not expected to occur in humans. They are used as a screening tool.

The 2008 preliminary Environmental Protection Agency (EPA)/Office of Pesticide Programs (OPP) risk assessment for the re-registration eligibility decision (RED) document has proposed a limit of 10 ppb, which is considered protective in residential settings against eye and other sensory irritation. This preliminary risk assessment has not been peer reviewed.

Regulatory standards and guidelines related to exposures to formaldehyde in occupational and non-occupational (residential) settings have been established by different governmental agencies and other organizations. The levels range from 16 ppb for the National Institute of Occupational Safety and Health (NIOSH) to 750 ppb for the Occupational Safety and Health Administration (OSHA) in occupational settings. The guidelines for non-occupational (residential) settings range from 8 ppb (ATSDR) to 100 ppb (ASHRAE and WHO).

Occupational standards and guidelines were developed for occupational settings involving healthy adult workers over an 8 or 10-hour work day. These values are not viewed as applicable to residential indoor air. VDH recognized the need to account for variations in response to formaldehyde's irritation effects in a large and varied population including children, adults, and seniors. Whether any one individual would experience irritation effects at a concentration within the range of values depends on their sensitivity to formaldehyde. For some individuals who are very sensitive that may be closer to the lower end of this range (e.g., 8 to 16 ppb) and for others it may be closer to the higher range (e.g.,100 ppb or higher). However, as exposure levels increase and/or as the time period for exposure increases (e.g., in the case of residents living in a newly-constructed mobile home), the likelihood of irritation reaction increases.

Application of the Guideline

VDH has provided this guideline for emergency residential situations and extended residential situations. This formaldehyde guideline has been developed solely for use in evaluating test data on indoor air levels of formaldehyde in temporary housing units to be provided by FEMA, and to assist with decision-making regarding acceptance of such units.

Recommendation

Based on the evaluation of current available scientific literature, VDH recommends use of a value of 16 ppb (0.016 parts per million, ppm) as the acceptance criteria for evaluating test data on indoor air levels of formaldehyde in FEMA temporary housing units. There is no evidence in the current scientific

literature, or in regulatory levels promulgated by federal agencies, to support the long-term exposure to the general population at higher levels. This value represents a provisional estimate of exposure levels likely to present minimal health risks to the citizens of the Commonwealth of Virginia, including the sensitive populations.

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